



Packets vs. Circuits

Why N+0 Ethernet Protection is Better Than the N+1 SDH/SONET Protection Scheme

Abstract

Summary

N+0 Ethernet protection vs. N+1 SDH/SONET

Many operators are considering, or are in the process of migrating, their backbone networks to all-packet transmission. Naturally, they are concerned about the protection mechanism available in packet-based systems and how it compares with the commonly used N+1 scheme in SDH/SONET networks. The protection mechanism employed in packet networks is N+0 Ethernet--new to many operators and not well understood. This Technical Brief describes the N+0 Ethernet protection scheme and traffic distribution technologies employed by Ceragon's Evolution IP Long Haul series to build redundant and resilient high-capacity, long-distance links. It compares traditional N+1 SDH/SONET protection, first, with Ethernet over SDH/SONET using LCAS and, then, with the technologically advanced, all-IP network protection scheme. It also explains the improvement in all-IP network utilization at all times and transmission conditions.



Transmission Network Performance and Availability

In today's data- and video-centric networks, performance degradation that results in data loss and dropped connections may be as critical as complete link unavailability. But link availability means far more than preventing failures. It also involves the prevention of performance degradation to keep data transmission at an acceptable level.

Traditional SDH/SONET long-distance microwave networks employ N+1 redundancy schemes where one channel is designated as a protection/reserve channel for N active channels. When one channel fails, the protection channel is brought into active service to maintain the traffic from the failed channel. However, in such a scheme, the failure of a second channel has no protection channel (it is being used already) and traffic from this channel is simply lost.

With the migration to Ethernet-over-SDH/SONET, new protection schemes could be introduced. Virtual Concatenation (VCAT)¹ and Link Capacity Adjustment Scheme (LCAS)², offered by Ceragon Long Haul radio equipment for several years, provide active and reliable protection. With LCAS, several SDH/SONET transport containers in a long-haul application, mainly VC-4/OC-3, form a group. Packets are mapped onto the group and distributed over the available members (carriers). Should one or more members fail, LCAS automatically distributes the packets over the remaining members. Quality-of-service (QoS) mechanisms ensure that high-priority traffic is transmitted unaffected. Unfortunately, this protection scheme is not hitless and causes packet loss every time one container is removed from the group. Furthermore, it does not offer adaptive coding and modulation (described later) to achieve the highest level of throughput under degraded conditions nor does it utilize the available spectrum efficiently as each member is limited to a maximum throughput of ~150 Mbps.

The advance of native Ethernet technologies and the shift to all-IP communications call for new ways to maximize network performance and link availability. New bandwidth-hungry services incessantly demand more capacity and require improved ways to utilize spectrum. Near-100% availability of voice traffic is a natural expectation with users demanding a consistently high level of quality for their VOIP communications and video channels. To address this ever-increasing demand, microwave equipment vendors must elaborate more efficient protection mechanisms for their all-IP networks (1) to provide the requisite high level of redundancy and resiliency and (2) to make sure that high-priority traffic is transmitted unaffected.

¹ Virtual concatenation (VCAT) is an inverse multiplexing technique creating a large-capacity payload container distributed over multiple small capacity TDM signals. (Wikipedia)

² Link Capacity Adjustment Scheme (LCAS) is a method to dynamically increase or decrease the bandwidth of virtual containers. (Wikipedia)



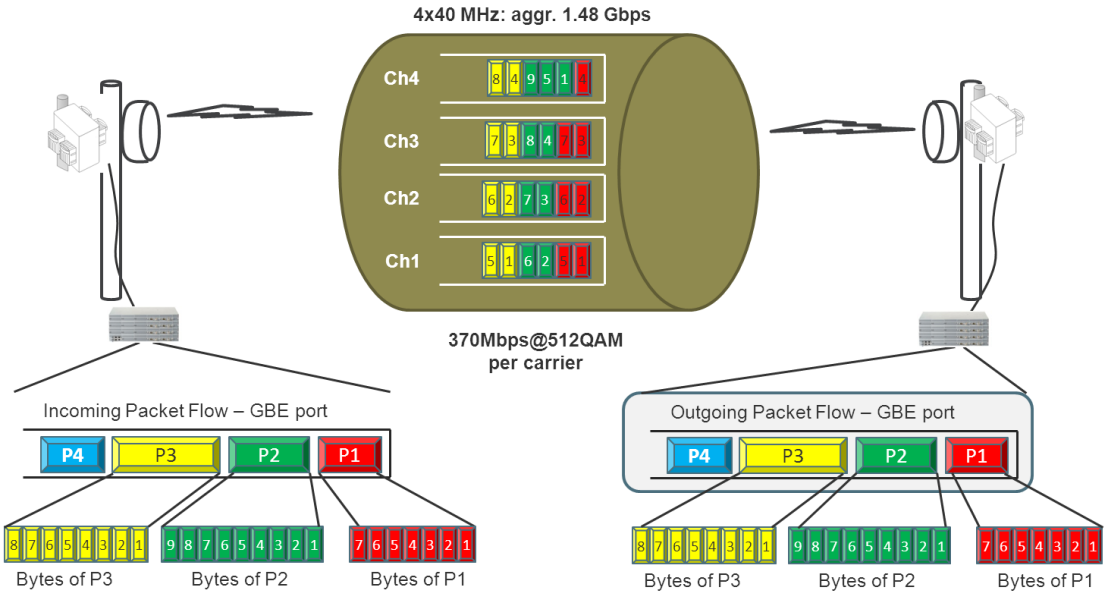
Multicarrier Adaptive Bandwidth Control (ABC)

Ceragon's Evolution Long Haul Series features Multicarrier Adaptive Bandwidth Control, the unique technology for traffic distribution over multiple RF carriers. It is an excellent solution for all-IP network protection. Multicarrier ABC dynamically adjusts total link capacity depending on the number of current channels and the sum of the available capacity of each to provide the highest throughput at any moment.

In ABC, the traffic from the Ethernet port is distributed to all available RF channels in a round-robin fashion independent of packet size and flow. This results in a single, high-capacity, efficient Ethernet link with a high level of resilience. If an RF channel fails, the overall throughput may drop, but the remaining capacity is always fully utilized. Ceragon's QoS scheduler ensures that high-priority traffic is transmitted unaffected. Low-priority traffic may be dropped if the link becomes congested.

Multichannel Adaptive Bandwidth Control

- Is an effective technology for transporting packets over multiple dynamic links
- Works at the Layer 1 level and is independent of frame types and packet flows (as opposed to Ethernet Link Aggregation, another technique that is sometimes employed)
- Automatically scales with available channels/links
- Supports an aggregated payload (Layer 2) of up to 8 channels ~ 2 Gb/s
- Changes to modulation are hitless – they introduce no bit errors or packet loss
- High-priority traffic is granted primacy and is transmitted without deterioration



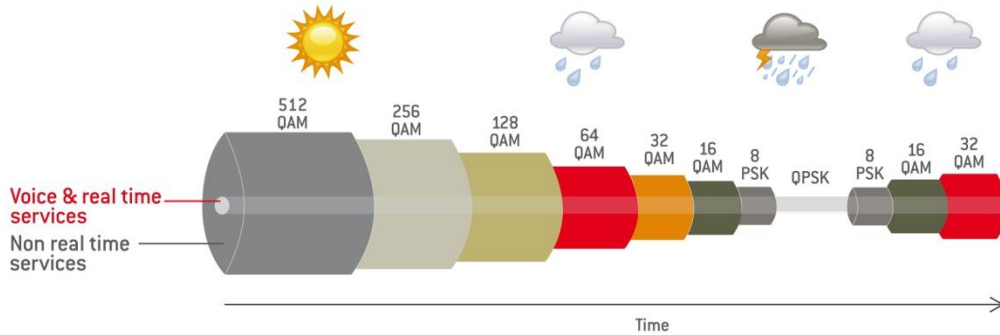
Multicarrier ABC at Full Capacity

Adaptive Coding and Modulation (ACM)

Ceragon’s Evolution Long Haul Series also features Adaptive Coding and Modulation (ACM). In ACM mode, the radio selects the highest possible link capacity based on received signal quality. If the signal quality is degraded due to link fading or interference, the radio automatically adapts by changing to a more robust modulation which will protect the signal even though this will cause a consequential deterioration of link capacity. Communications can be maintained at this level for as long as necessary. When signal quality improves, ACM automatically senses the improved condition and reverts to the faster level of modulation. Link capacity is automatically restored to its original level.

The capacity changes are hitless (no bit-errors are introduced). During the period of reduced capacity, traffic is prioritized based on Ethernet QoS and TDM priority settings. In cases of over-congestion, the Ethernet or TDM traffic with lowest priority is dropped. TDM capacity per modulation state is configurable as part of the TDM priority setting. ACM regulation works independently in the two traffic directions.

Adaptive Coding and Modulation usually comes into play very infrequently—perhaps only for a few hours per year.



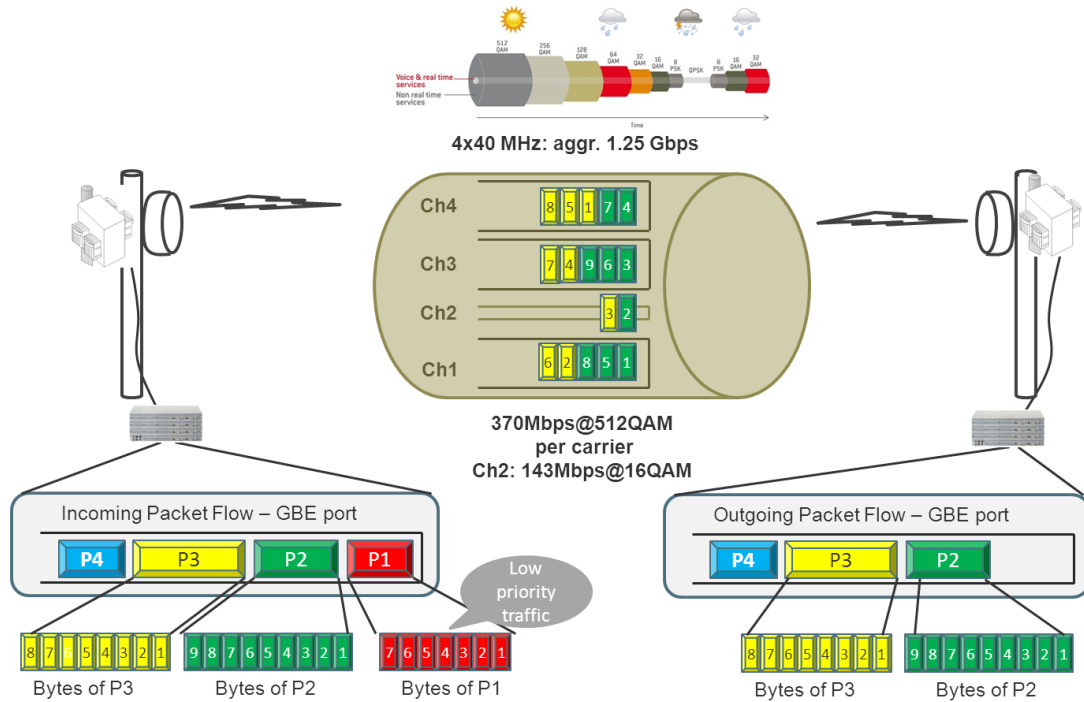
Adaptive Coding and Modulation (ACM)

Adaptive Coding and Modulation:

- Automatically scales down the microwave link’s modulation under degraded conditions
- Acts early and pre-emptively before errors are introduced
- Protects long data flows from time-out, but with reduced speed

N+0 Ethernet Protection


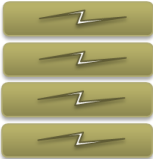

With Evolution IP Long Haul employing N+0 Ethernet protection, all channels are active and the entire transmission capacity is used for payload traffic. Unlike SDH/SONET N+1 protection schemes, no channel has to be dedicated to protection; all can participate in the maximization of total throughput. Multichannel Automatic Bandwidth Control technology provides a reliable protection mechanism to ensure that the traffic is transmitted unaffected even when the link has degraded. If a channel has degraded to a state of failure, it is automatically excluded from the distribution and overall capacity is reduced concomitantly. Unlike the N+1 SDH/SONET scheme, N+0 Ethernet protection provides reliable transmission even when more than one channel is lost. At the same time, with Adaptive Coding and Modulation, Evolution IP Long Haul radios automatically adjust modulation with current link conditions protecting vital transmissions and data flows even in degraded conditions.



Multicarrier ABC with ACM and QoS with One Degraded Channel



N+0 Ethernet Protection vs. N+1 SDH/SONET Protection

	N+1 SDH/SONET	N+0 LCAS SDH/SONET	N+0 Ethernet Protection with Multichannel ABC	Benefits of N+0 Ethernet Protection
Number of protection carriers	1 dedicated carrier for protection 	All carriers protect each other 	All carriers protect each other 	With ABC, all carriers are used for transmission giving higher throughput and embedded protection for all channels
Scalability	Fixed capacity per carrier, only one channel for protection	Pipe scalable in steps of 155 Mbps only	Highly scalable across the whole pipe	Scalable ABC pipe with ACM results in higher overall throughput and less outage
ACM	No	No	Yes	Modulation scales under reduced conditions
Max capacity per carrier	STM-1 or 63xE1/OC-3 or 84xT1	~150 Mbps	28 MHz >200 Mbps 40 MHz >275 Mbps 56 MHz >350 Mbps	Improved capacity
Hitless switching	Yes	No	Yes	Graceful degradation of link outage
Link availability	Protection provided to only one channel at a time. No QoS. No ACM	High availability, LCAS and QoS. No ACM	Highest availability due to ACM, ABC and QoS	Highest availability

Benefits of Native Ethernet Protection Beyond SDH/SONET Protection

- Increased flexibility
- Improved availability as link may not be 100% utilized when fading occurs
- Allows higher aggregate capacity as protected bandwidth is also used during normal operation
- Scales automatically with failures or fading
- Re-scales automatically to original settings when service returns



Summary

Ever since Ceragon pioneered the SDH Long Haul market in 1992, it has continuously worked to provide its customers with the latest technologies to build high-reliability, future-proof, long-distance links. As networks evolve to Ethernet-over-SDH/SONET and to all-IP, link protection mechanisms need to not only offer transmission reliability and network redundancy, but must also insure maximum capacity at every level of link quality.

Ceragon's proprietary method for traffic distribution and protection, Multichannel ABC utilizing Adaptive Coding and Modulation, is a superior technology for protecting link traffic while it gracefully scales down the link in case of fading, at all times providing the highest possible overall throughput. Compared to the traditional N+1 SDH/SONET approach or Ethernet over SDH/SONET with LCAS, Multichannel ABC provides higher resiliency and better link redundancy which results in higher availability of service and a more capacious link.

ABOUT CERAGON

Ceragon Networks Ltd. (NASDAQ: CRNT) is the premier wireless backhaul specialist. Ceragon provides high capacity LTE/4G wireless backhaul solutions that enable cellular operators and other wireless service providers to deliver voice and data services, enabling smart-phone applications such as Internet browsing, music and video.

With unmatched technology and cost innovation, Ceragon's advanced point-to-point microwave systems allow wireless service providers to evolve their networks from circuit-switched and hybrid concepts to all IP networks. Ceragon solutions are designed to support all wireless access technologies, delivering more capacity over longer distances under any given deployment scenario. Ceragon's solutions are deployed by more than 200 service providers of all sizes, and hundreds of private networks in more than 130 countries.

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